

Chapter 4 Structural Analyses and Design

4-1. Stress Criteria

a. Concrete. Criteria for the design of reinforced concrete elements of the closure structures are given in EM 1110-2-2104.

b. Structural steel. Criteria for the design of structural steel closure gates shall be based on the provisions given in EM 1110-2-2105. Design for the normal (usual) load cases shall limit the allowable stress to 5/6 of the allowable given in AISC (1986). This "5/6" modification factor is used because Corps criteria require a higher safety factor for hydraulic structures than AISC uses for building design. Allowable stresses 1/3 greater than the normal stresses shall be used for load cases that include water to the top of the closure, wind, earthquake, or short duration loads. Load and resistance factor design criteria for structural steel closure gates are provided in EM 1110-2-2105 and AISC (1986).

c. Structural aluminum. The design of aluminum shall be based on the provisions of the Aluminum Association (1986). The allowable stress shall be limited to 5/6 of the basic values given therein for normal load cases. This allowable stress should be increased by 1/3 for design cases that include water to the top of closures, wind, earthquake, or short duration loads.

4-2. Loading Criteria

Load cases I1 through I4, given in Chapter 4 of EM 1110-2-2502 for the design of inland flood walls, shall be used for the design of closure structures. An additional load case, Case I5, is included for the design of the gate hinges and support structure for swinging gates. These load cases are described below. Load cases for closure structures loaded in coastal areas are given in Table 4-3 of EM 1110-2-2502.

a. Case I1, Design flood load. Closure in the closed position; water level on the unprotected side at the design flood level (top of wall less freeboard); water level on the unprotected side at or below the gate sill elevation.

b. Case I2, Maximum flood load. Same as Case I1 except water level is at the top of the closure on the unprotected side.

c. Case I3, Earthquake load. Water level at the usual water elevation during the nonflood stage; earthquake-induced lateral and vertical loads are acting. (Note: This case is applicable to support structures only.)

d. Case I4, Short-duration loading. Closure is subjected to short-duration loads with the gate in any position. The gate should be designed for a wind load of 15 psf during opening and closing and for a wind load as specified in EM 1110-2-2502 when the gate is in the closed position. Other special loads may be necessary for closures in hurricane flood structures to ensure safe operation during gate closures. For example, gates could be subjected to storm wave loadings during gate closing operations if gate closure is delayed as long as possible to allow for the movement of railway traffic during a storm.

e. Case I5, Gate swinging. Hinged gate of a gate closure in any position; subjected to dead load only.

4-3. Design Analysis Criteria

The design analysis criteria for closure structures are presented in detail in the design examples included in Appendices B through F. Provisions for designing and determining the stability of supporting posts, walls, and sills of closures are not included in this guidance. Chapters 4 and 5 of EM 1110-2-2502 should be referred to for overturning and sliding stability requirements. Flotation criteria are given in EM 1110-2-3104. The design of pile foundations should comply with the criteria in EM 1110-2-2906.